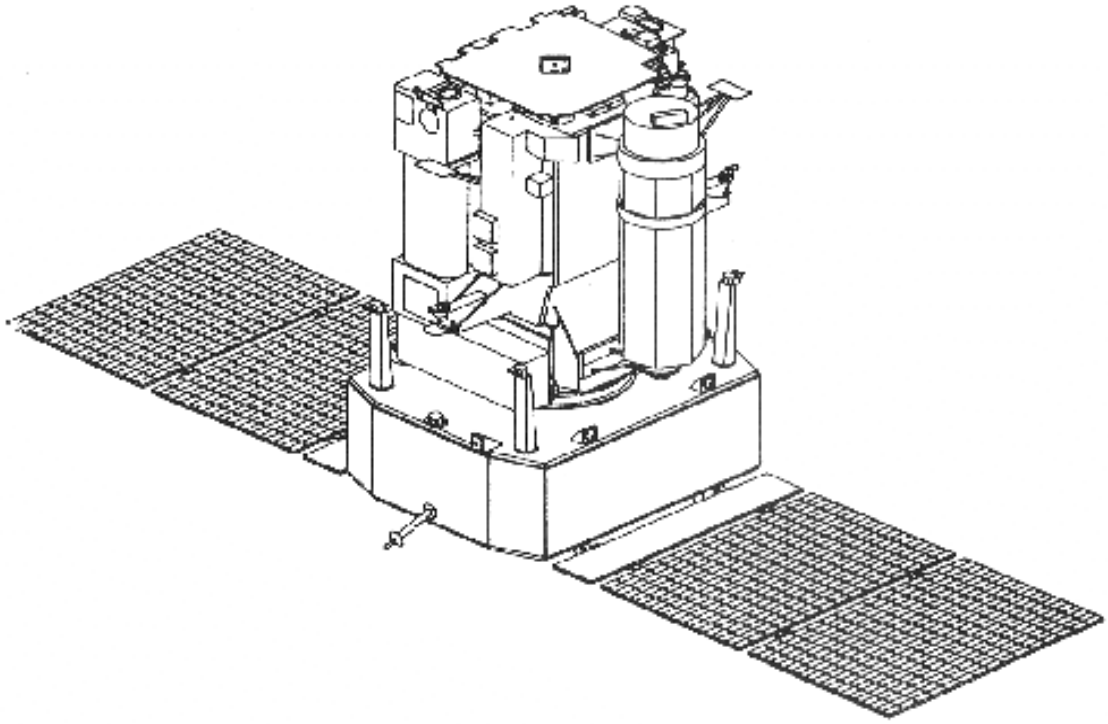
Goddard Space Flight Center, Greenbelt

SOHO
Monthly Trending Report
October 2011

Ref: SOHO/PRG/TR/736 Nov 10, 2011



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1 SOHO Spacecraft Status Synthesis

General	Science data collection was nominal Spacecraft was rolled in inverted position on Oct 20 and is now at a constant 180-degree roll angle (BOGART phase started on 2010-Oct-29)	
Power	Solar array degradation	21.44% after 191 months of flight, equivalent to 1.35% per year.
DHSS	SSR	SEF's: average of 0.87 evt/min
	Tape Recorder	Used with good performances
	OBT drift	Average of 0.4 ms for the period
RF	Transponders/Antennae	Nominal.
AOCS	Reaction Wheels	RW 1, 2 and 3: work fine
		RW 4 was not used this month
	Fine Sun Sensor	FPSS-A works fine**.**
	Star Tracker	SSU-A works fine.
Propulsion	Fuel	Remaining fuel: about 115kg
	Thruster branch A	Used for thruster maneuvers
	Thruster branch B	Not used this month
Maneuvers	Station Keeping	SK-75 performed on Oct 20
	Momentum Management	Performed on Oct 20
	Roll	+180-degree roll on Oct 20
Thermal	Overall temperatures	on expected trend
	SVM Equipment	FPSS plate temperature at 45C
	PLM status	All experiments ON with: - SUMER sensor Substitution Heater ON (circuit 82 at 30%) - GOLF sensor Substitution Heater ON (circuit 68 at 30%) - since Jan 6 2011, VIRGO uses its redundant power supply (VIPWB) - since Mar 23 2011, CTOF is OFF with its Substitution Heater ON (circuit 64 at 60%)
S/C Hardware failures:	Loss of fast loop of receiver 1 on April 23, 1997 Loss of all 3 gyros; September & December 1998 Loss of battery 1; March 7, 2002 HGA antenna Z motor stuck; May 2003 (still possible to move the antenna around Z axis with dual winding activation) Loss of FSPAAD on Apr 21, 2004	

2 Detailed Trending Analysis

2.1 Power Sub-system

The performance of the power system is nominal. All housekeeping parameters are within limits.

Solar Array degradation:

The degradation this month was 0.02% (based on estimated Solar Irradiance value).

Total degradation after 191 months of flight is 21.44%, which corresponds to 1.35% per year (refer to plot in Annex 5.1.1).

Current Margin:
The present current margin (seasonally changing), based on the minimum value of shunt current (PISW2, for section 8) and the main bus peak current, as reported in TM (33.5A), is 8.7A (see plot in Annex 5.1.2).

The monthly highest values recorded by the onboard min/MAX monitoring of the main bus current was 32.5A; the lowest was 26.7A (see plot in Annex 5.1.3).

2.2 Data Handling Sub-system

The performance of the Data Handling Subsystem is nominal.
The housekeeping parameters were stable.

CDMU:
The average onboard time drift was 0.4ms with a maximum delta of 1.3ms.
The last OBT frequency adjustment was done on August 3 2011.

No DMA error this month.

This month single bit errors have been reported in COBS RAM memory without any operational impact (always at the same address as observed since Sept 2008).

Solid State Recorder:
The SEF count, at 0.87 evt/min, is average for the period (see plot in Annex 5.2.1 and Annex 5.2.2 (daily average of SEF counts since 2004)).

Transponder:
Good performances of transponders and High Power Amplifiers (nominal and redundant equipments).

HGA/APME:
High Gain Antenna nominally pointed around Y-axis; Z-axis at -16.7 degrees.

Tape Recorder:
TR was used this month and showed good performances.

2.3 Attitude and Orbit Control Sub-system

The status of AOCS is nominal; all housekeeping parameters are within limits.

Star tracker

There was one star swap this month (anomaly S11-0033):
On October 6 at 21UT, at the beginning of a gap, there was a jump in position and magnitude for the current guide star (star 18050038, 6.7 Mv, in slot 2), therefore values were frozen and then false event was reported which induced a swap to star in slot 1.
The FOT recovered the nominal guide star (1) at 21:44. Overall the roll drift induced by the star swap was limited to 7 arcseconds.
Swap occurred in the past (2010-Sep-1) for the same guide star (18050038).It was the first star swap since the beginning of the Bogart phase (Oct 29 2010).

On Oct 10, star in slot 1 became not eligible (likely due to false event) (anomaly S11-0034), such star was not the guide star. It was marked eligible again by the FOT during the following pass (on the same day). No effect on attitude control and pointing.

The background level is stable at 688 mV (for gain 4).

FPSS
As shown by plot in Annex 5.8, FPSS degradation is as expected.

Reaction Wheels, CRS drift and Roll maneuver

The reaction wheels' friction torques are given in Annex 5.3 to 5.5 (speeds vs torques).

Since the CRS drift value uploaded after the Momentum Management (at 18:20 on Oct 20) was too big (typo: comma understood as separator for thousands instead of usual dot before decimal digits), the spacecraft rolled too early.

In order to correct for this unplanned "CRS drift roll", 3 segments of rolls were successively performed:

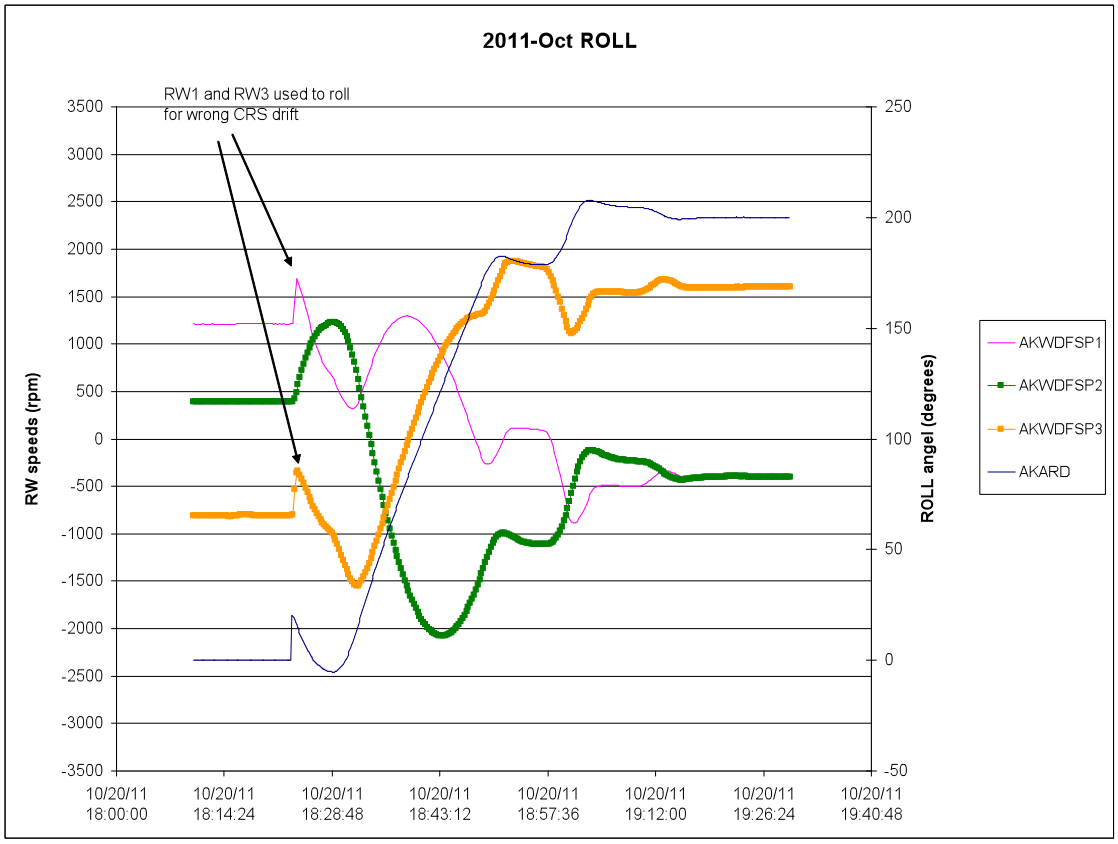
- at 18:26 a +180-degree roll (as initially planned) (started at 18:26), which in addition cleared the CRS drift value (reset to zero by the CRP_profile procedure),

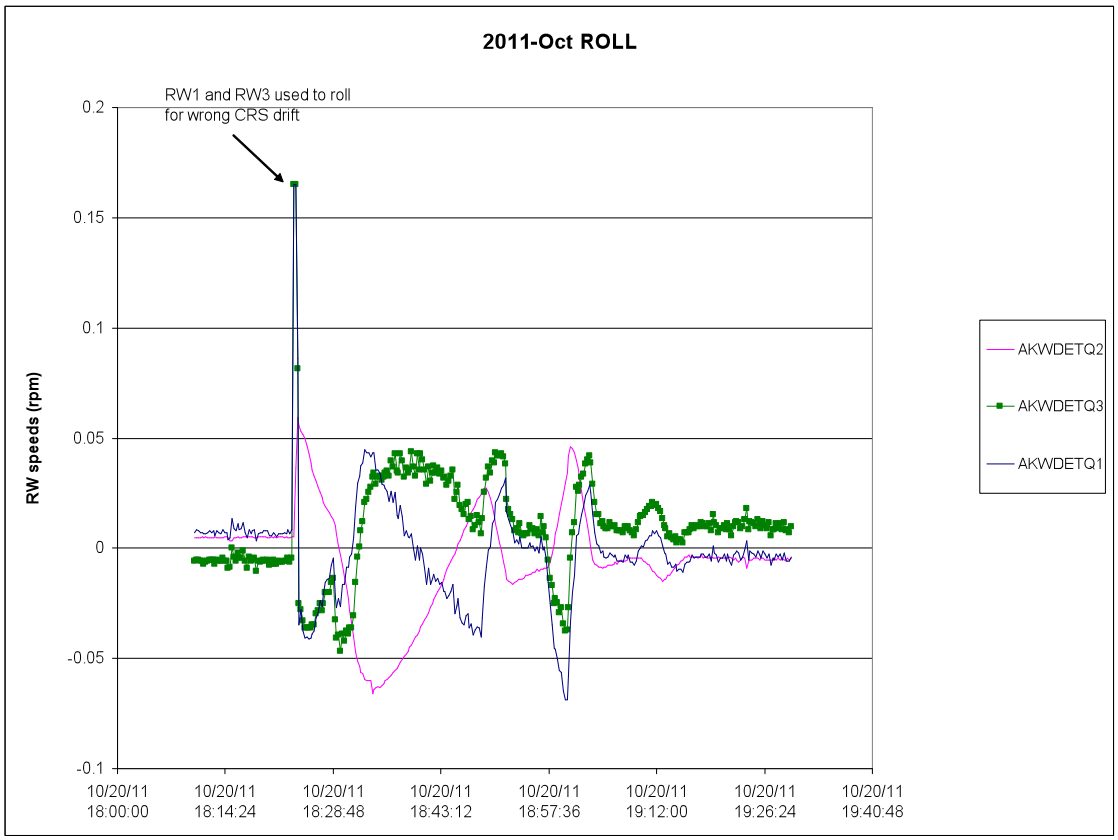
- at 18:58 a +25-degree correction (aimed at increasing wheel 1 speed, then spinning at 110rpm)

- at 19:08 a -5-degree roll put the RW speeds at the expected target of -410 / -400 / 1600 rpm.

Later on, star tracker mapping data indicated the roll angle was 179.82 degrees.

The plots below show the RW speeds and commanded torques (note the max torque value (0.165 Nm) when wrong CRS drift induced a roll):





Finally these roll maneuvers demonstrated the CRP mode is robust and showed good performances of the reaction wheels.

The maneuver script and procedure will be improved so that:
- the CRS drift is not uploaded prior to a roll maneuver (not needed)
- and its value is checked to be within ground limits.

Overall the 180-degree roll is summed-up below:

180 degrees Roll **2011-Oct-20**

Start time (UTC)	Angle (degrees)	Profile Duration	
2011.293.18:26	180	performed in 3 segments	
Wheel speeds (rpm)	Wheel 1	Wheel 2	Wheel 3
Initial	782	1188	-902
Final	-414	-396	1596

2.4 Propulsion Sub-system

2.4.1 Thruster Maneuvers

On October 20 were executed:
- a Station Keeping: delta-V of +0.037 m/s
- a Momentum Management: 3 axes
- a +180-degree Roll (see description above)

SK-75 **2011-Oct-20**

Start time (UTC)	Delta-V (m/s)	Fuel used (kg)	Duration (min)
2011.293.16:05	0.0367	0.0322	4.5

Thruster	Pulses	Pulse length (ms)	On time (s)	Interval (s)
2A	4	89.55	0.358	80
3A	14	988.381	13.837	20
4A	14	936.143	13.106	20

Wheel speeds (rpm)	Wheel 1	Wheel 2	Wheel 3
Initial	276	336	-1264
Final	288	329	-1269
Delta (Final – Initial)	12	-7	-5

A new ratio between thruster 3 and 4 on-time was used (1.056 vs 1.042 before and since Dec-2003) and showed good performances (SK 0.64%cold as reported by FDF), however it was a pretty small station keeping.

Momentum Management first segment **2011-Oct-20**

Start time (UTC)	Thruster	Pulses	Pulse length (ms)	On time (s)	Interval (s)	Duration (min)
2011.293.16:45	5A (R)	31	104.2	3.2302	35	18.1

Wheel speeds (rpm)	Wheel 1	Wheel 2	Wheel 3
Observed Initial	288	331	-1268
Observed Final	1028	302	-532
Observed Delta (Final – Initial)	740	-29	736
Expected Delta (Final – Initial)	738	-29	738

Momentum Management second segment **2011-Oct-20**

Start time (UTC)	Thruster	Pulses	Pulse length (ms)	On time (s)	Interval (s)	Duration (min)
2011.293.17:15	4A (Y)	11	215.7	2.3727	35	1.2

Wheel speeds (rpm)	Wheel 1	Wheel 2	Wheel 3
Observed Initial	1028	302	-532
Observed Final	1241	336	-780
Observed Delta (Final – Initial)	213	34	-248
Expected Delta (Final – Initial)	213	34	-247

Momentum Management third segment **2011-Oct-20**

Start time (UTC)	Thruster	Pulses	Pulse length (ms)	On time (s)	Interval (s)	Duration (min)
2011.293.17:32	1A (P)	2	79.7	0.1594	60	3

Wheel speeds (rpm)	Wheel 1	Wheel 2	Wheel 3
Observed Initial	1241	336	-780
Observed Final	1212	395	-807
Observed Delta (Final – Initial)	-29	59	-27
Expected Delta (Final – Initial)	-29	58	-27

For each Momentum Management segment, the delta between final and initial wheels speeds was as expected.

2.4.2 Remaining fuel (PVT analysis)

According to PVT estimate, there are about 115.1kg of fuel remaining (see Annex 5.6).

Fuel used this month: total of 0.039 kg

- Station Keeping; 0.032 kg
- Momentum management: 0.007kg

2.5 Thermal sub-system and thermoelasticity

All temperatures are within limits.

The plots of the sun shield temperatures since launch are given in Annex 5.7.1.

3 Status of Anomalies

Anomalies during the reporting month:

Anomaly	Date	Title	Origin	Close-out reference
S11-0032	2011-10-01	CDMU SEU Counter Increase	SVM	CDMU single bit errors at the same location 0xDF9F.
S11-0033	2011-10-06	Guide Star Swap	SVM	Recovered by FOT within 1 hour
S11-0034	2011-10-10	Star 1 Went ineligible	SVM	Star marked eligible again the same day by the FOT

The anomaly spreadsheet (see trend files in the annex) lists the status of all spacecraft anomalies since launch.

4 Configuration

4.1 Flight Software Configuration

Central On Board Software	V14 with: - patch 2 (gyroless functions) - patches of SubFormats 5 and 6 - patch for Intermittent recording V3 - patch for TCM in macros - patch for RW speed limits updating - patch to correct Scheduler Bug - patch for UVCS safing (thermally more robust in case of ESR or off-pointing) - patch to increase the number of Standard Monitorings
Attitude Control Unit	FM_3_0 (i.e. FM_2_3A in PROM + ACU patch 8 for gyroless) + ACU patches 9, 10, 12, 13, 14, 15, 16 V2 and 17
Star Tracker	FM-5.0 with SSU patch 2A
Solid State Recorder	Version 2.03.0. (= Version 2.02 + SEF/DEF and IT2 patch)

4.2 Recent Changes (OCD's and UB's)

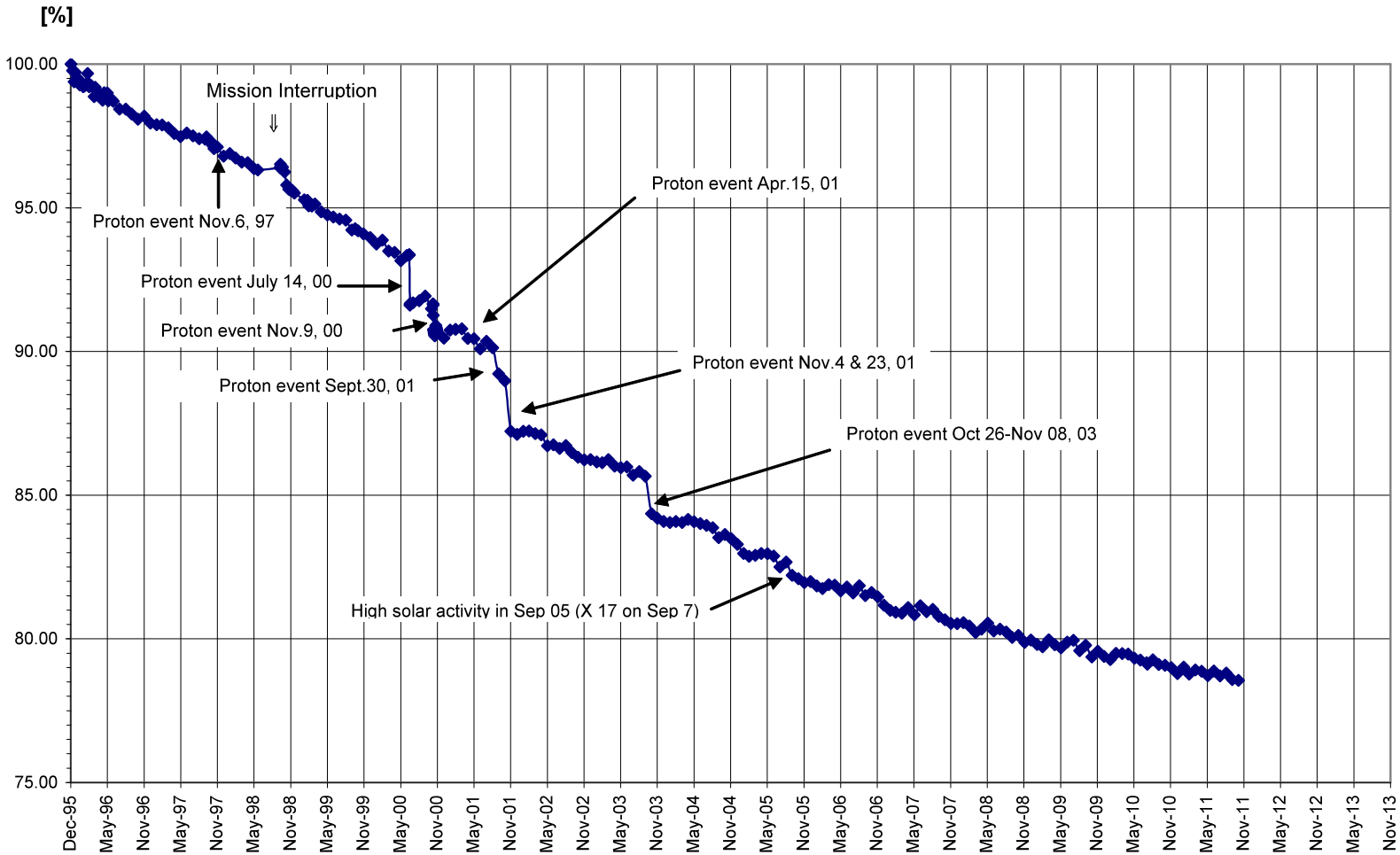
UB56	12-Feb-09	Updates of Gyroless UM (ESR recovery strategy, Reaction wheel speeds limit updated function, HGA-Z motor failure, simplified Propulsion branch pressure check) and provide electronic copies of ACU, CAE, RW and FPSS UM.
2364	17-Feb-09	SUMER substitution heaters settings (76 at 100% and 83 at 80%)
2365	23-Feb-09	SVM phases optimization
2045	23-Feb-09	FPSS-B tests (re-execution of an "old" OCD)
2367	3-Mar-09	SVM Non Operational Heaters reduction
2368	6-Mar-09	Wheels ground limits
2371	21-Apr-09	Switch OFF kevlar cutter 2
2376	21-Apr-09	CDS: reduce sensor substitution heater (circ 62)
2377	21-Apr-09	CELIAS: substitution heaters reduction (circ 64, 65 and 66)
2378	21-Apr-09	LASCO/EIT: reduce substitution heaters (circ 70, 71 and 87)
2379	21-Apr-09	UVCS: reduce electronics substitution heater (circ 85)
2385	5-May-09	HPA thermal limits
2387	12-May-09	SSU-B test
2389	1-Jun-09	Ground limits (tuned for a list of SVM parameters)
2392	6-Jun-09	If needed switch ON CDS electronics substitution heaters (not executed)
2406	14-Aug-09	Move HGA Z-axis +197 steps to -16.7 degrees (dual coil) to reduce Keyholes
2417	6-Oct-09	GOLF thermal limits and electronics substitution heater set at 90%
2418	6-Oct-09	APME-B switched OFF
2420	19-Oct-09	Enable PLM circuits already at 0%
2421	19-Oct-09	Battery 2 thermal threshold
2423	22-Oct-09	Upload ACU patch 16
2424	22-Oct-09	Tank and RWL heaters put in mode 2
2429	5-Nov-09	PLM heaters tuning (-7.6W)
2430	5-Nov-09	APMM Temperature limits
2431	2-Nov-09	SWAN thermal settings
2435	16-Nov-09	ATPTA-B Temperature limits
2443	23-Jan-10	SSR Memory Unit 9 switched back ON
2448	3-Feb-10	Upload COBS UVCS safing patch (SMILE CSEC018)
2453	8-Mar-10	VIPWA-B YLL and RLL decreased
2468	2-Aug-10	ATLVA-B YLL decreased from 12C to 11C
2478	29-Oct-10	PLM heaters reduction for Bogart (-12.5W)
2479	1-Nov-10	Widen ground limits for gyros outputs (ASFD55L, AXFD11, AXFD12)
2480	9-Nov-10	Upload COBS patch for more standard monitoring channels
2481	9-Nov-10	Test of COBS patch for more standard monitoring channels
2493	18-Jan-11	Switch back ON SSR Memory Unit number 10
2494	25-Jan-11	Upload ACU patch 16 V2 (clear mapping buffer spread over 16 slots)
2503	22-Apr-11	Upload ACU patch 17 (RSL processing changes for Bogart mission)
2504	22-Apr-11	Reduce CTOF nominal substitution heater from 80% to 60%
UB57	21-Jul-11	Update of COBS and ACU Gyroless SW (COBS patch for more St Mon and for UVCS; ACU patches 16 and 17). Updates of Applications SW UM, St Mon and Macros for Bogart.

5 ANNEX

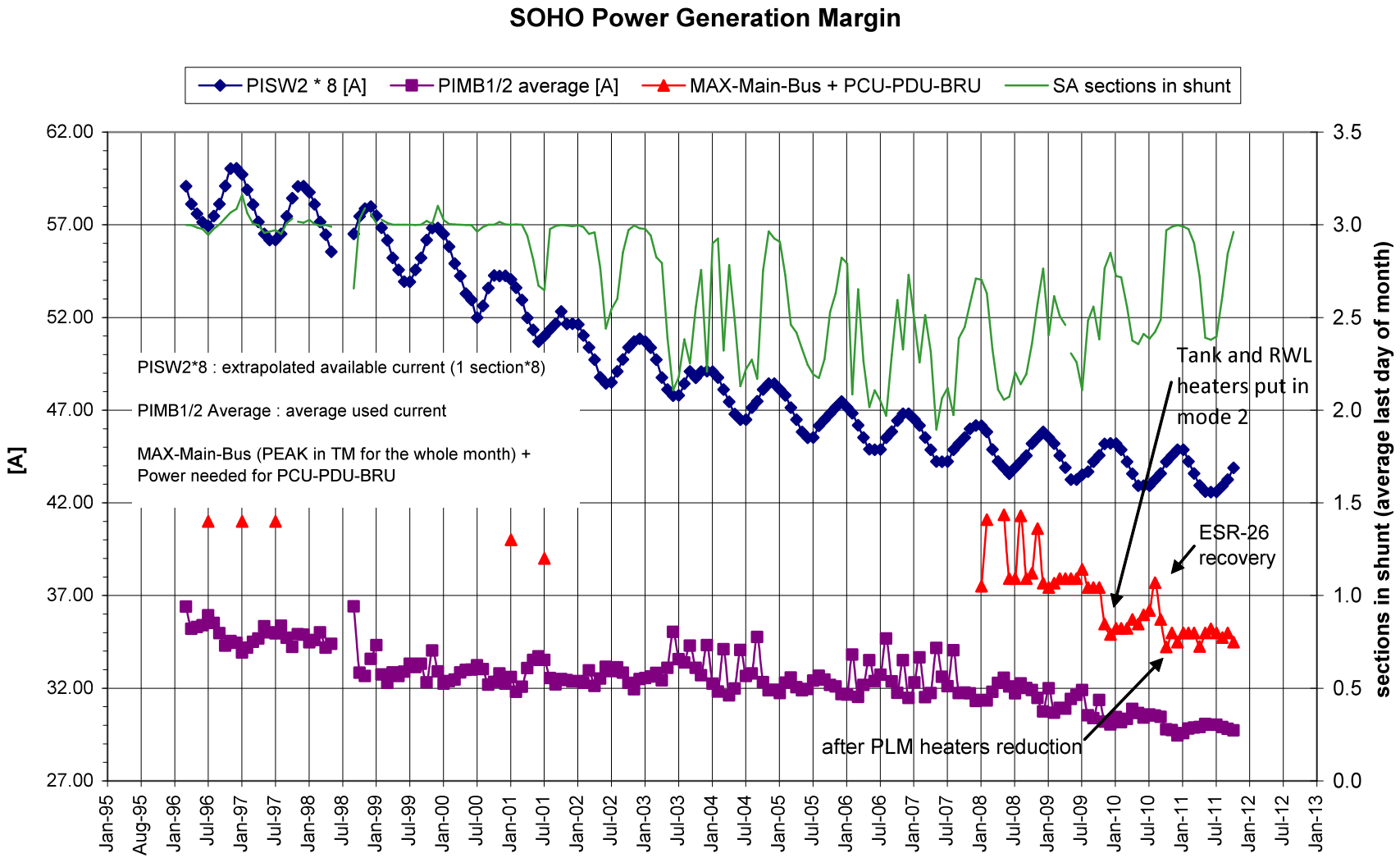
5.1 Power plots

5.1.1 Solar array degradation

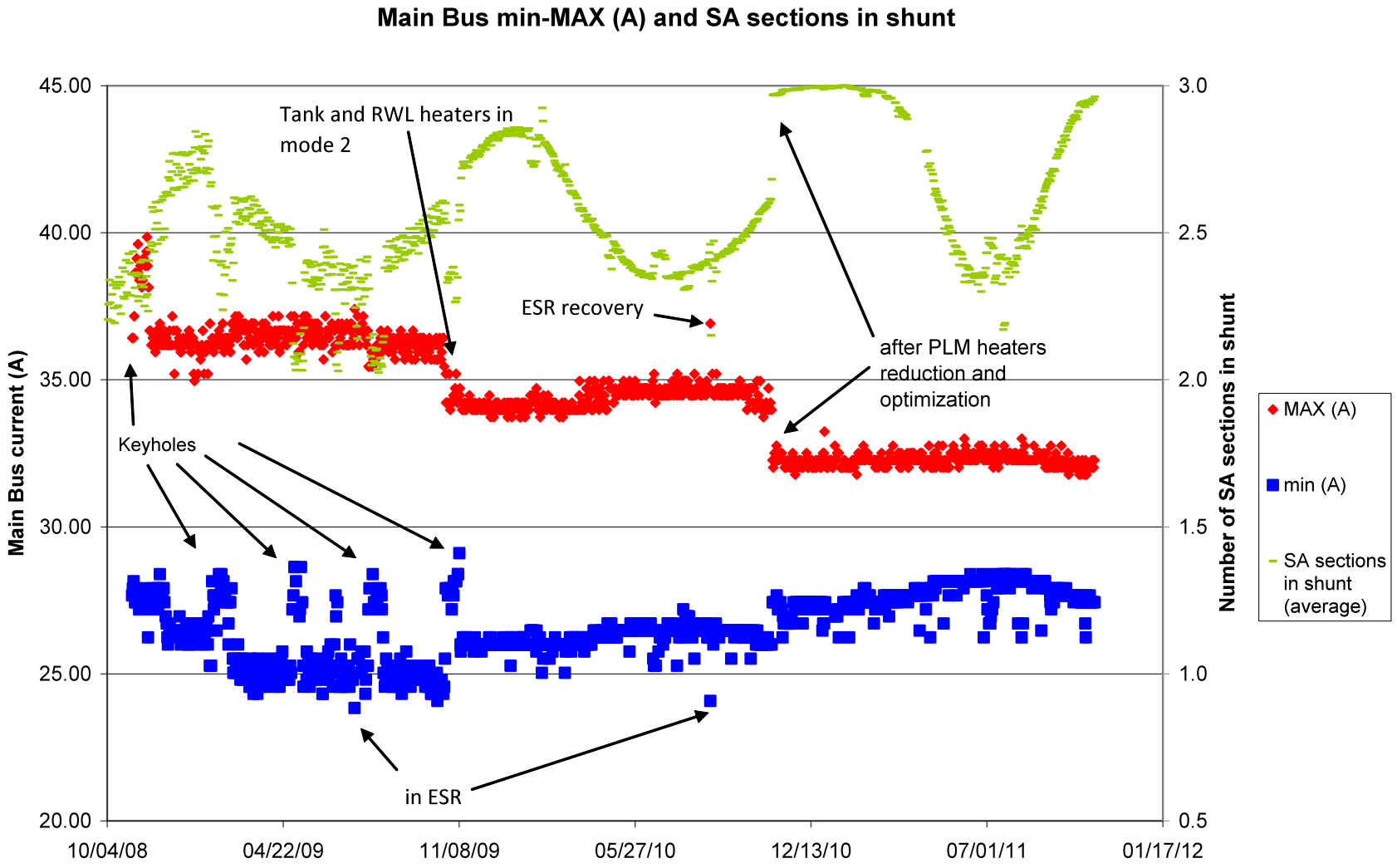
SOHO Solar Array Degradation, based on the average of the two section currents (PISW1 and PISW2)



5.1.2 Power margin

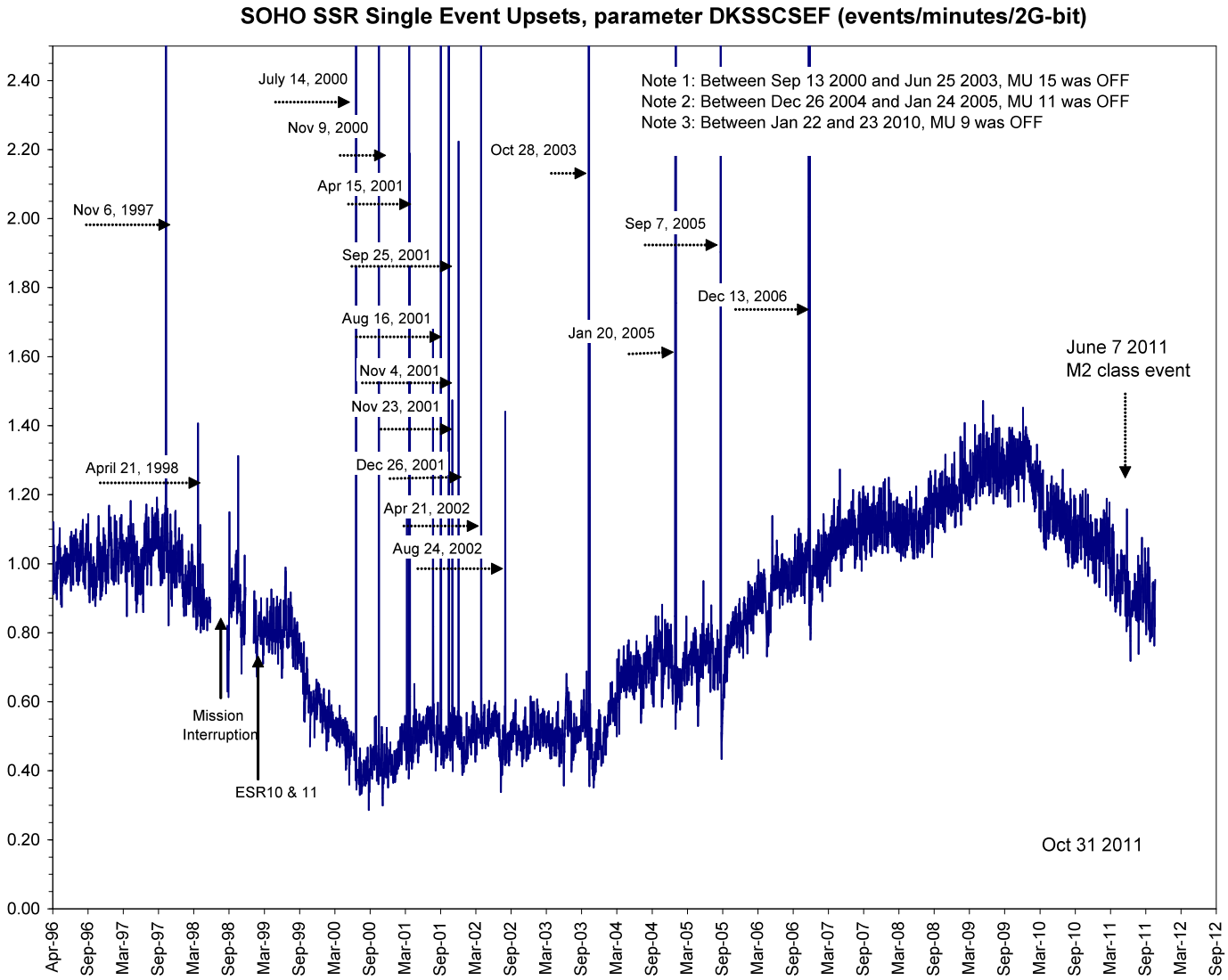


5.1.3 Main Bus Current daily min-MAX and Number of SA sections in shunt

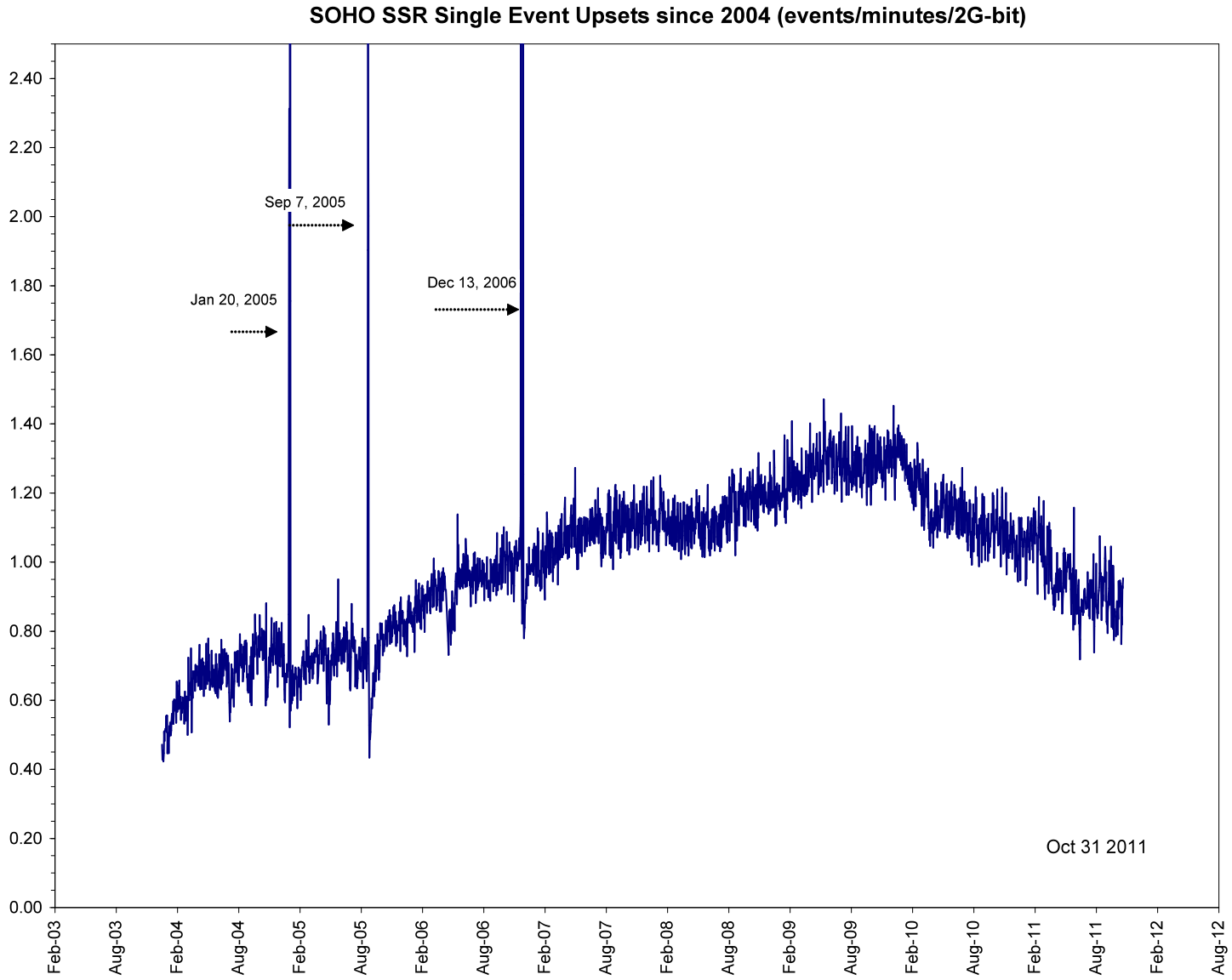


5.2 SSR / SEU Rate

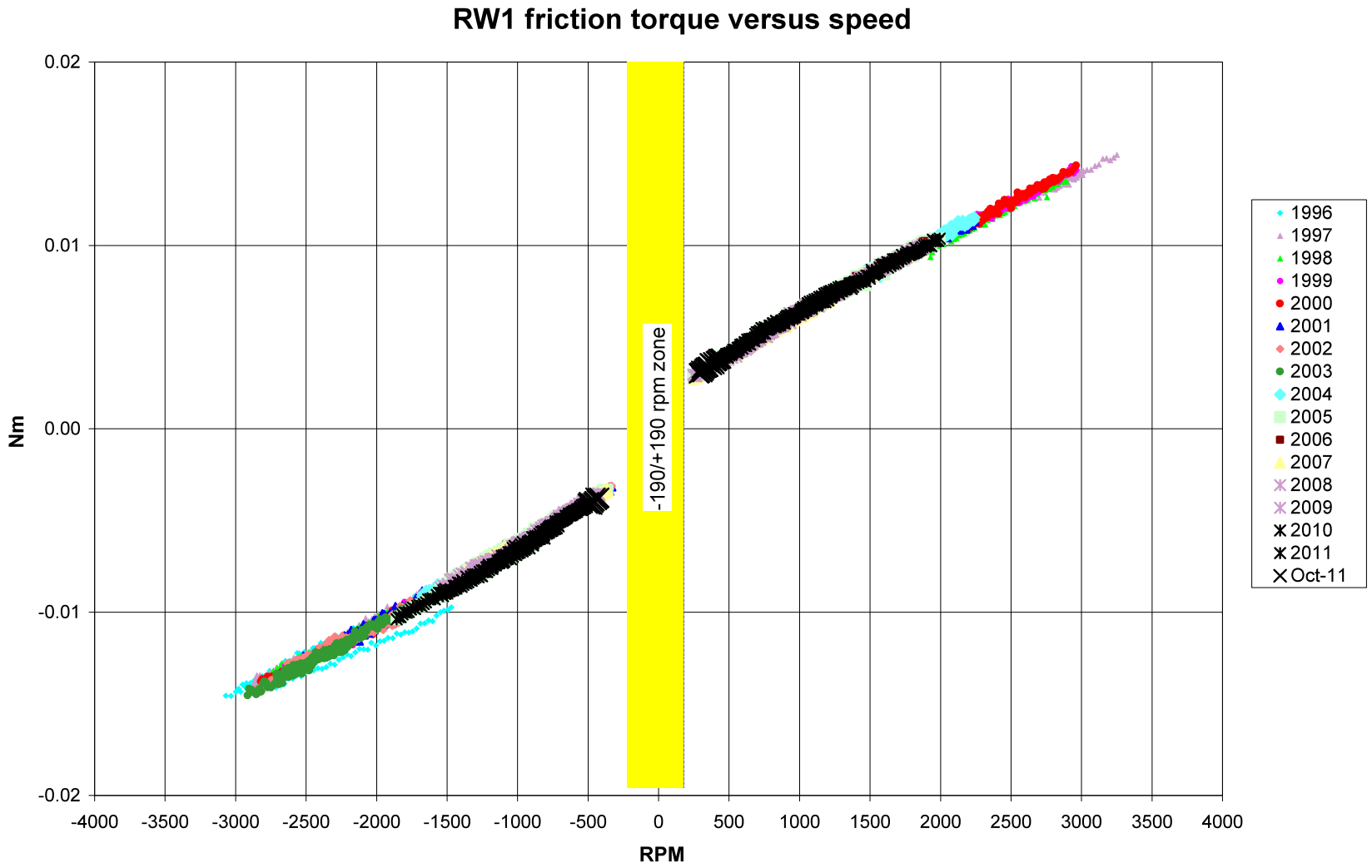
5.2.1 Since Launch



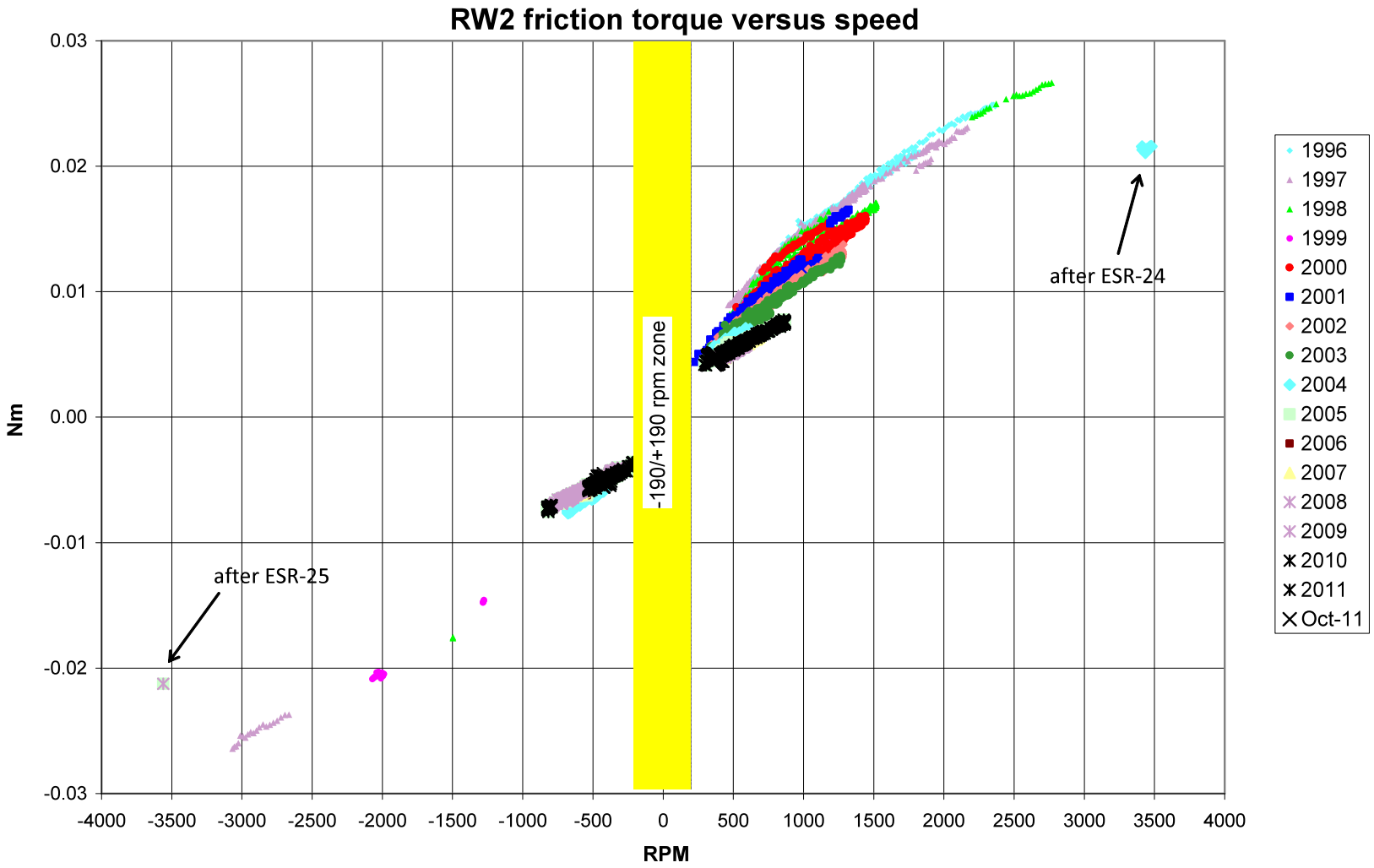
5.2.2 Since 2004



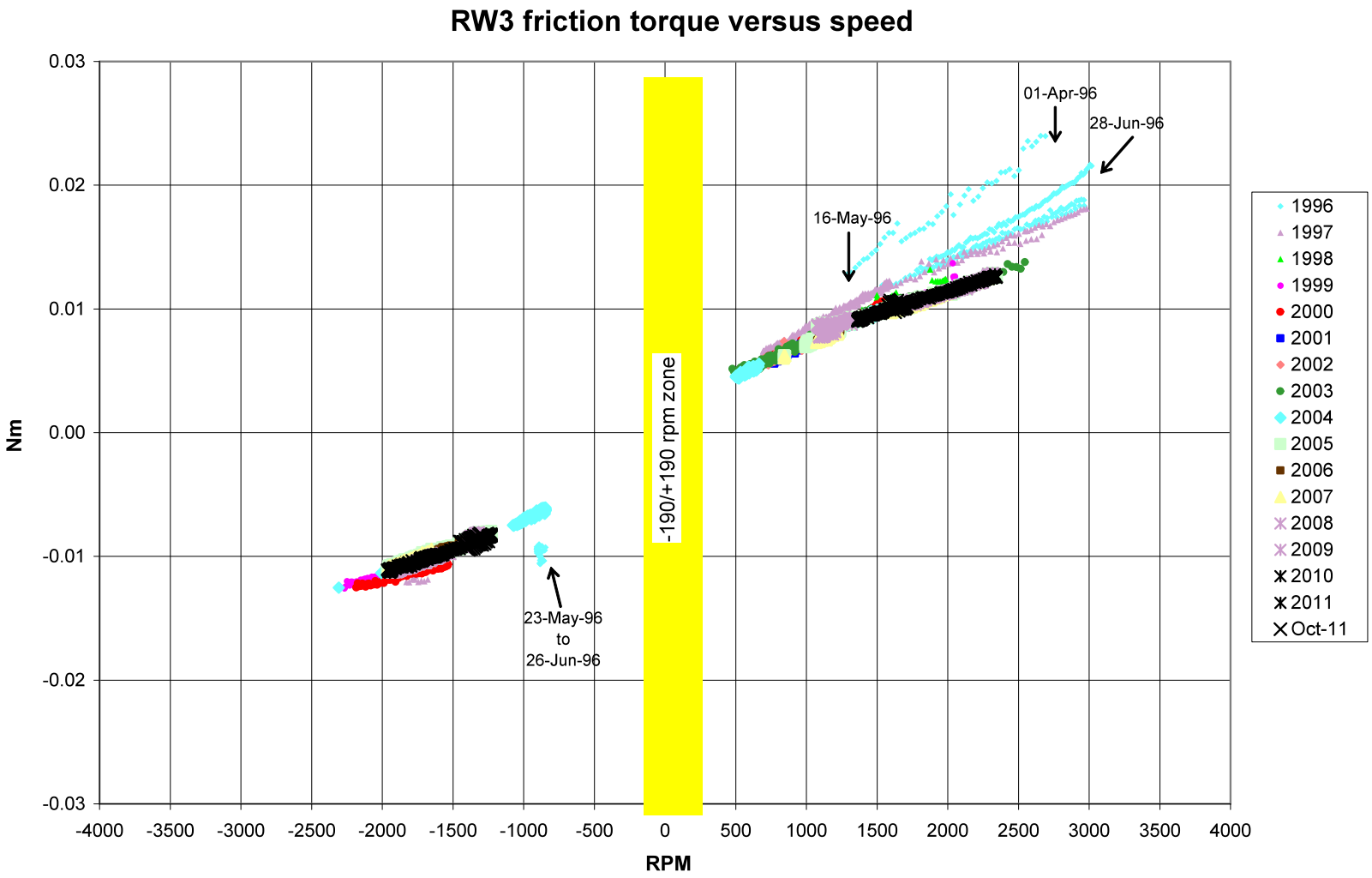
5.3 Reaction Wheel 1 friction



5.4 Reaction Wheel 2 friction

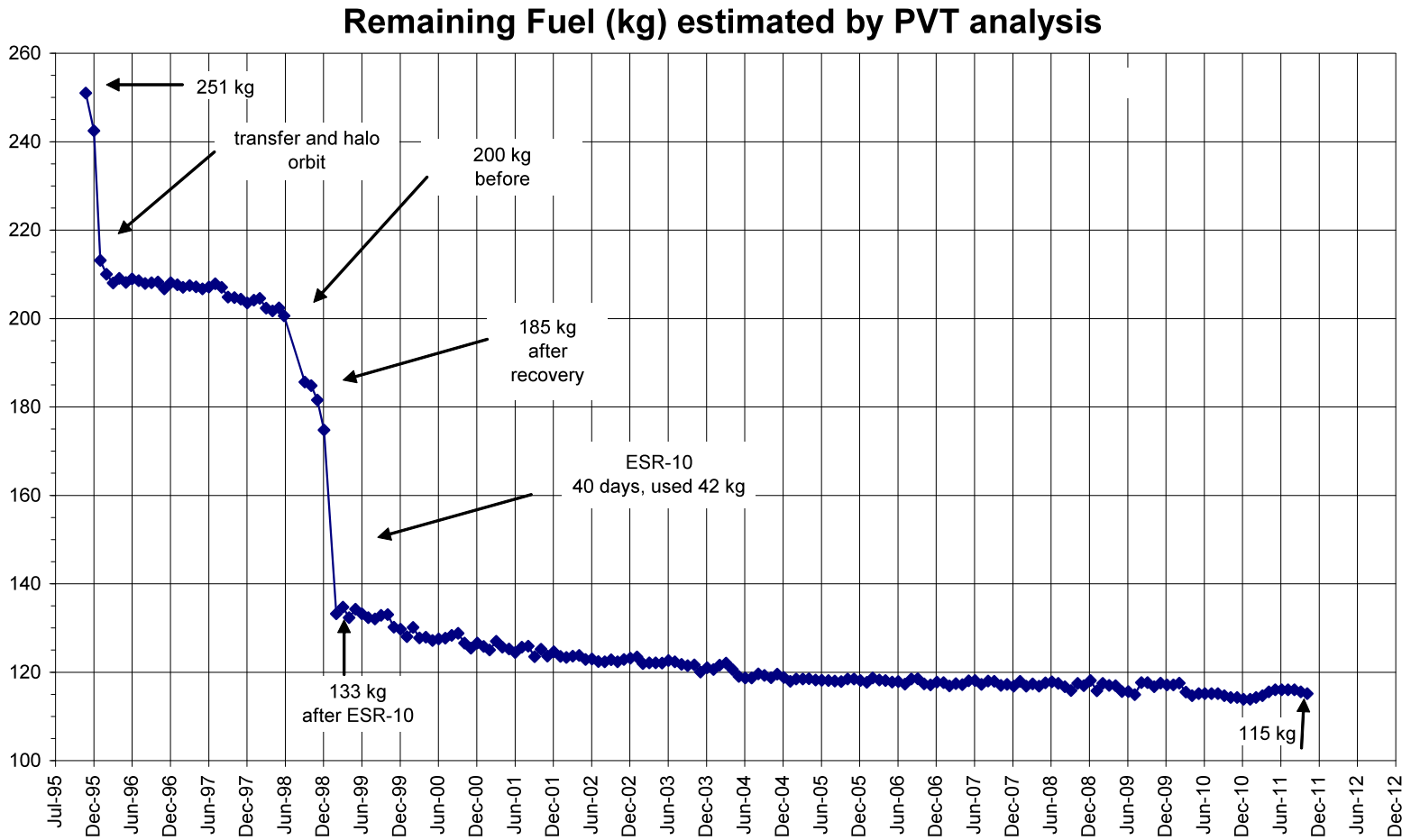


5.5 Reaction Wheel 3 friction



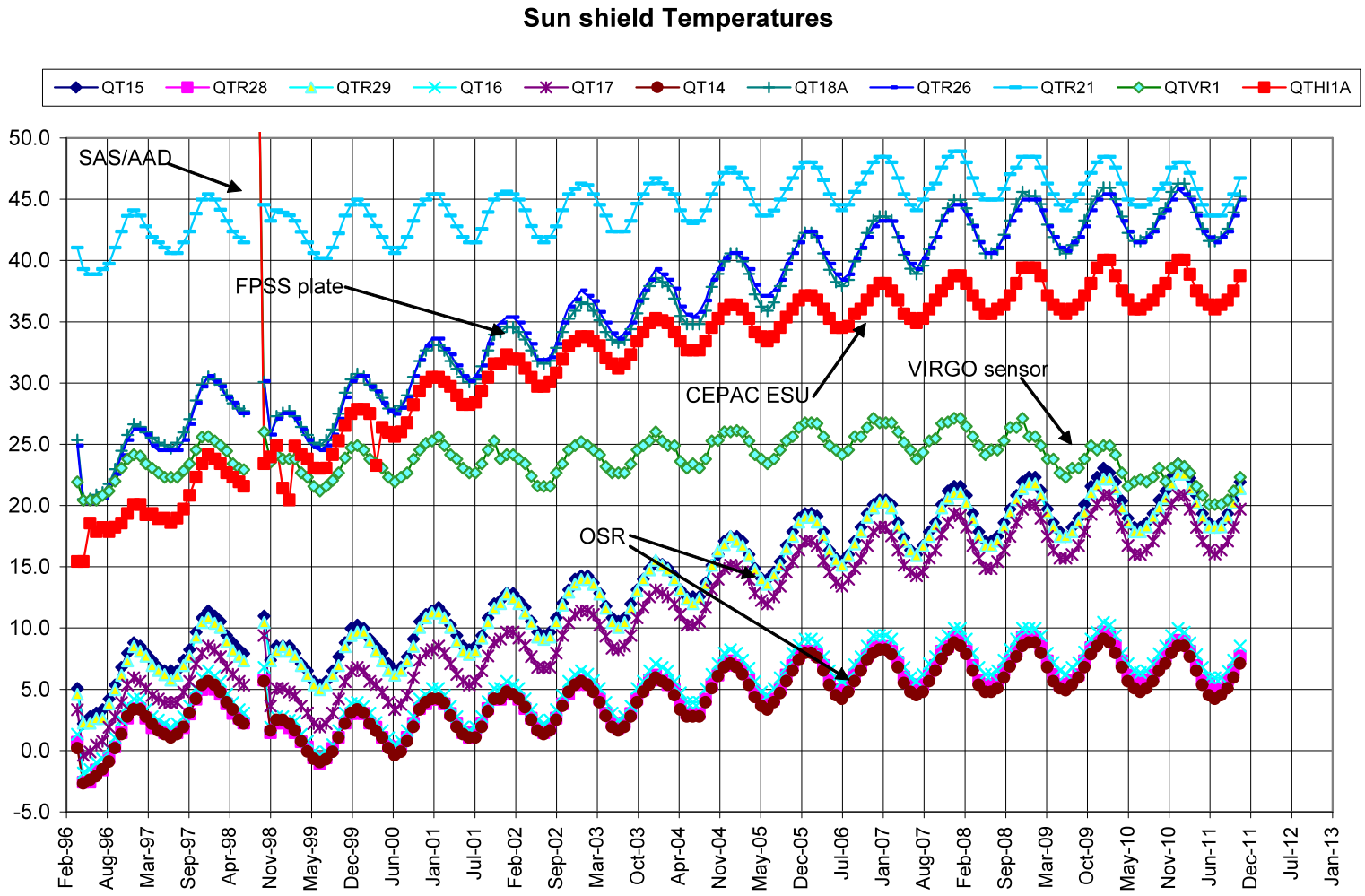
5.6 Propulsion plots

5.6.1 Remaining amount of fuel

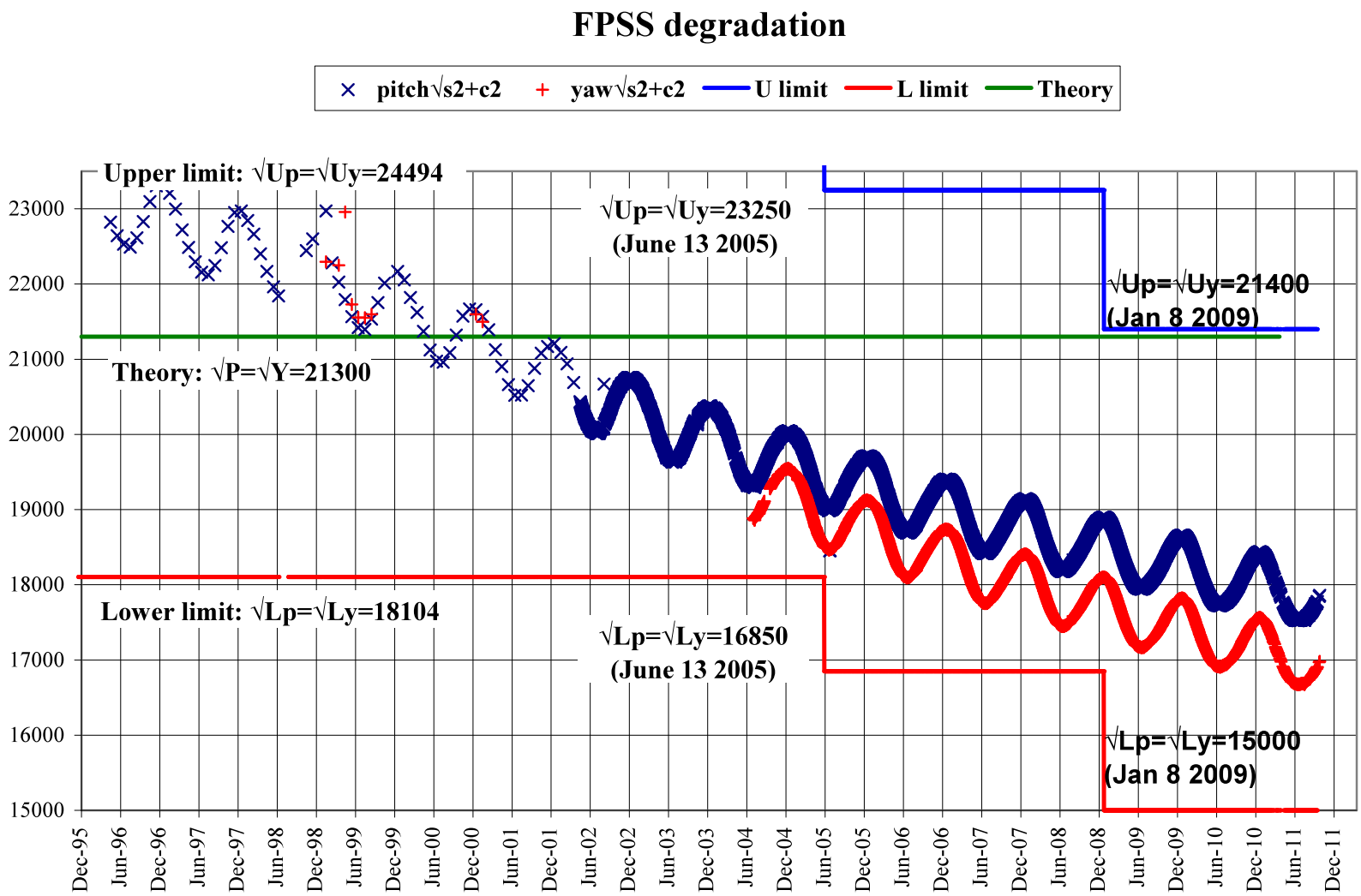


5.7 Plots of temperatures

5.7.1 Top panel



5.8 FPSS degradation



5.9 SOHO Event List

Month	Day	Year	1995-12-02	Affected	Day of Year	Flight Day	Time (UTC)	Event
JAN	6	2011	2011-01-06	VIRGO	7	5516	20:50	VIRGO switched ON on B-side (was OFF since Jan 2 at ~4UT)
JAN	12	2011	2011-01-12	Spacecraft	12	5521		***Beginning of keyhole period f or D27***
JAN	14	2011		Spacecraft	14	5523		Transponder Swap (1->2)
JAN	19	2011		Spacecraft	19	5528	10:45	SK-72: jets 1,2 ; dV -0.011m/s. Wheels at -1235 / -522 / 2182 rpm
JAN	19	2011		Spacecraft	19	5528	11:20	Momentum Management 3 segments (jets 5A, 4A and 2A)
JAN	25	2011		Spacecraft	25	5534	10:58	180° Roll, satellite in normal position. Final wheels speeds: 1850/ 477 / -1610 rpm
JAN	25	2011		Spacecraft	25	5534		ACU SW patch 16 Version 2 uploaded
JAN	25	2011		Spacecraft	25	5534		Transponder Swap (2->1)
JAN	30	2011		Spacecraft	30	5539		***End of keyhole period f or D27***
MAR	23	2011		CELIAS	82	5591		CELIAS switched OFF and later on turned back ON with CTOF kept OFF
APR	12	2011		Spacecraft	102	5611		***Beginning of keyhole period f or D27***
APR	15	2011		Spacecraft	105	5614		Transponder Swap (1->2)
APR	22	2011		Spacecraft	112	5621	11:00	SK-73: jets 1,2 ; dV -0.092m/s. Wheels at 244 / 810 / -1716 rpm
APR	22	2011		Spacecraft	112	5621	11:35	Momentum Management 3 segments (jets 5A, 1A and 3A)
APR	22	2011		Spacecraft	112	5621	13:04	180° Roll, satellite in normal position. Final wheels speeds: -493/ -510 / 1394 rpm
APR	22	2011		Spacecraft	112	5621	13:10	CTOF substitution heater (circuit 64) reduced from 80% to 60%
APR	22	2011		Spacecraft	112	5621		ACU SW patch 17 uploaded
APR	22	2011		Spacecraft	112	5621		Transponder Swap (2->1)
APR	24	2011		Spacecraft	114	5623		***End of keyhole period f or D27***
JUN	30	2011	2011-07-08	SUMER	181	5690	12:30	SUMER campaign
JUL	9	2011		Spacecraft	190	5699		***Beginning of keyhole period f or D27***
JUL	12	2011		Spacecraft	193	5702	17:35	Transponder Swap (1->2)
JUL	19	2011		Spacecraft	200	5709	15:30	SK-74: jets 3,4 ; dV 0.010m/s. Wheels at -1482 / -423 / 1631 rpm
JUL	19	2011		Spacecraft	200	5709		Momentum Management 3 segments (jets 5A, 4A and 1A). Final wheels speeds: -1306 / -509 / 1727 rpm
JUL	22	2011		Spacecraft	203	5712	15:08	180° Roll, satellite in normal position. Final wheels speeds: 1243 / 500 / -1833 rpm
JUL	23	2011		Spacecraft	204	5713	11:20	Transponder Swap (2->1)
JUL	27	2011		Spacecraft	208	5717		***End of keyhole period f or D27***
OCT	11	2011		Spacecraft	284	5793		***Beginning of keyhole period f or D27***
OCT	13	2011		Spacecraft	287	5796	20:25	Transponder Swap (1->2)
OCT	20	2011		Spacecraft	293	5802		SK-75: jets 3,4 ; dV 0.037m/s. Wheels at 290/ 330/ -1270 rpm
OCT	20	2011		Spacecraft	293	5802		Momentum Management 3 segments (jets 5A, 4A and 2A). Final wheels speeds: 1210 / 400 / -810 rpm
OCT	20	2011		Spacecraft	293	5802	18:23	180° Roll (4 segments), satellite in 180-degree position. Final wheels speeds: -410 / -400 / 1600 rpm
OCT	20	2011		Spacecraft	293	5802	21:50	Transponder Swap (2->1)
OCT	22	2011		Spacecraft	295	5804		***End of keyhole period f or D27***

5.10 Trend Files

The table hereafter gives the names and contents of the trend files, which are available on request from the authors of this document.

Topic	File name	Description
General	SOHO Events.xls	Log file of all the major SOHO events since launch
	Anomalies.xls	List of all the spacecraft anomalies with their closure reference
Power	SA Degradation.xls	Solar arrays data and degradation
	Power Trend Long.xls	Since April 96 daily average of power parameters for the last day of each month
	P_ESA_MM_1B.xls	Daily value of onboard min/MAX of main bus current since Nov 2008
DHSS	DHS Trend Long.xls	Since April 96 daily average of DHSS parameters for the last day of each month
	SEF Overall.xls	Daily rate of Single Event Failure on the Solid State Recorder (since launch)
	Tape Recorder.xls	Tape recorder parameters (when used)
RF	RF Trend Long_NEW.xls	With the automation, measurements not input anymore by console operator. This file is not maintained, its content has been included in RF Trend Long_fromITPS.xls
	RF Trend Long_fromITPS.xls	Uses ITPS to automatically get ground stations measurements for RF trending. Previous values since launch are also recorded in this file.
AOCS and Propulsion	Wheels Friction Long.xls	Wheel speeds and torques (daily average) + estimation of external disturbance torques since April 96
	Wheels Spikes.xls	Listing of all the spikes on Wheel speeds TM (follow up on the wheel speed TM anomaly).
	AOCS HK PVT Analysis.xls	AOCS housekeeping parameters with also the remaining amount of fuel (PVT analysis) and the SSU background level.
	PROS-thrusterOnTime.xls	Branch A thrusters firing times since launch.
	SSU SEU Stat.xls	Guide star and SEU information for each day of the month
	SSU SEU Log File Sum Up.xls	Guide star losses and star swaps since launch
	AOCS Counters.xls	Statistics on AOCS timers (AKNBSCH and AKTIMERB) counts per format over 1/2 hour on the last day of each month, since March 2000
Thermal	Temp SVM.xls	SVM temperatures since April 96
	Temp PLM.xls	PLM temperatures since April 96

6 Distribution List

GSFC	H. BENEFIELD N. PISTON E.SOTER G. DIXON Jr	M. LEE R. BURNS L. JOHNSON	B. FLECK J. GURMAN T.v. OVERBEEK
ESTEC	J. ELLWOOD	P. RUMLER	F. TESTON
		P. POINAS	P. STRADA
EADS ASTRIUM Toulouse	JP. OLIVE M. JANVIER	D. LEBRETON P. TEMPORELLI	P. AYACHE A. REDON
EADS ASTRIUM	W. EDWARDS		
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